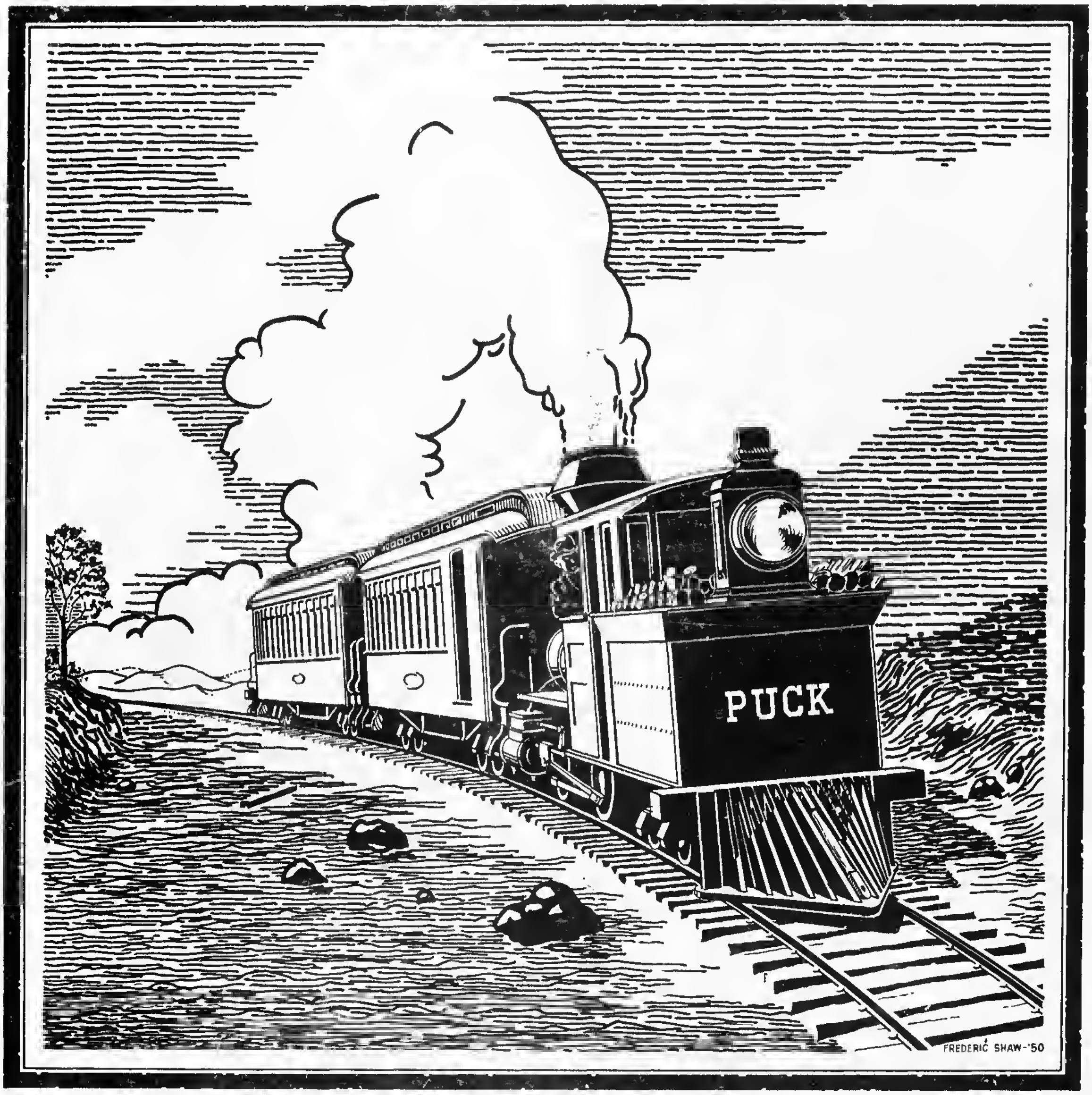
THE FIRST TWO-FOOT GAUGE RAILROAD

THE BILLERICA & BEDFORD OF MASSACHUSETTS

- 1877 -



RAILROADIANS OF AMERICA

NEW YORK

BOOK NO. 4

$15.00
2.81

THE

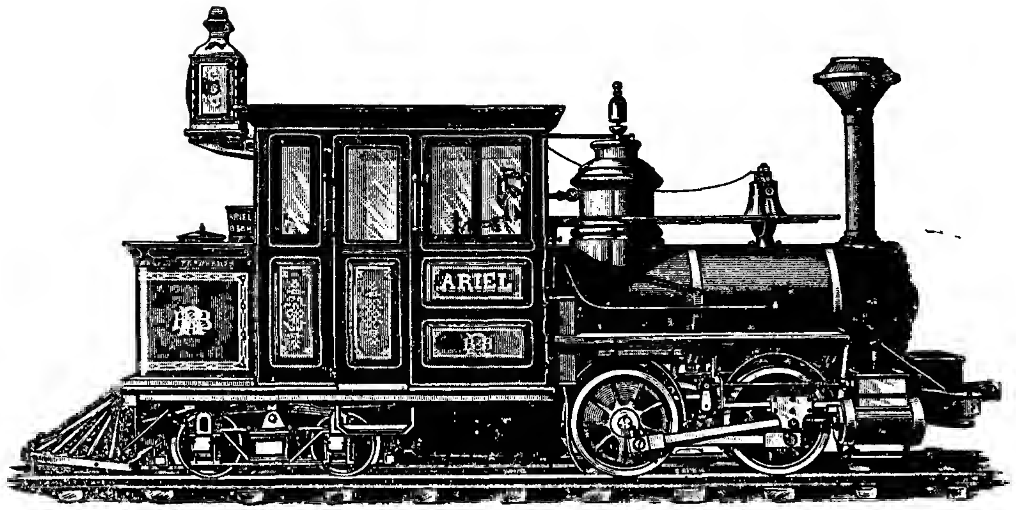
BILLERICA & BEDFORD

2-FT. GAUGE RAILROAD

A DESCRIPTION, WITH ILLUSTRATIONS, OF ITS LOCATION, PERMANENT WAY AND ROLLING STOCK.

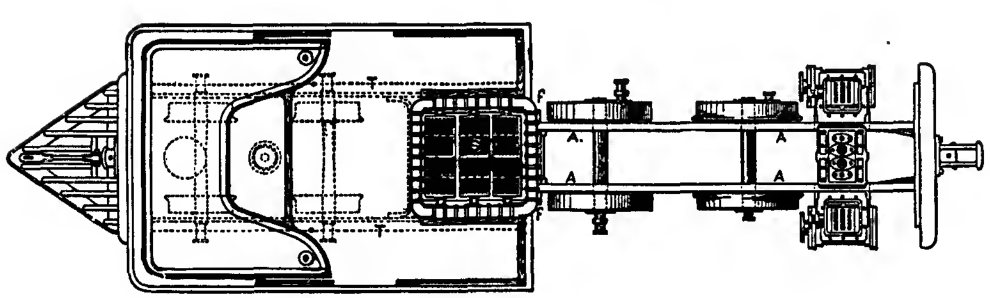
NEW YORK:
PUBLISHED BY THE RAILROAD GAZETTE.
1879.

REPRINTED FOR THE
RAILROADIANS OF AMERICA
by the
MORRISTOWN DUPLICATING SERVICE
MORRISTOWN - NEW JERSEY
AUGUST 1950



"FORNEY" LOCOMOTIVE FOR THE BILLERICA & BEDFORD (2-ft. Gauge) RAILROAD.

Built at the Hinkley Locomotive Works, of Boston, in 1877



PLAN OF LOCOMOTIVE FOR THE BILLERICA & BEDFORD (2-ft. Gauge) RAILROAD.

Foreword

The *RAILROADIANS OF AMERICA* present this *HISTORY OF THE BILLERICA & BEDFORD RAILWAY* as its Book No. 4, to fill an interest in the little two-foot narrow gauge railways which made history in our Country, and are now extinct.

The Billerica & Bedford Railroad was short-lived and ill-starred, as it was chartered in 1876; opened for service on November 28, 1877; in the hands of Receivers in 1878; and sold in bankruptcy June 6, 1878. It had two locomotives, four passenger cars and seven freight cars, all of which were sold to the Sandy River and Rangely Lakes Railroad in Maine. The two locomotives were built in Boston by Hinkley in 1877, and intended normally to run backwards- that is, tender first.

Patient searching through the files of the New York Public Library by our Vice President, Harold Lessersohn, brought this interesting and unusual pamphlet, originally published in 1879, to light. Through the courtesy of the New York Public Library it was made available for publication. The Simmons-Boardman Publishing Company, successors to the original publishers of the pamphlet, graciously gave their permission for us to republish it, so that the story of this little-known and short-lived Massachusetts two-foot gauge railway may be told to present day students of railroad history. The splendid cover drawing and graphic map, which are an addition to the original text, were drawn by our talented Western Vice President, Frederic Shaw. Our President, Milton Bernstein supplied the interesting little cut of the town of Billerica at the time of the railroad.

Other books published or sponsored by the *RAILROADIANS OF AMERICA* are: Book No. 1, (now out of print), a history of the New York, Susquehanna & Western Railroad; Book No. 2, containing several articles of interest to railroad and locomotive historians, including the history of the Sixth Avenue Elevated Railway of New York; Book No. 3, a profusely illustrated history of Delaware & Hudson motive power. A complete index of the material in *BALDWIN LOCOMOTIVES AND BALDWIN MAGAZINE* was published in 1949. Copies of the foregoing books may be purchased for $2.00 per copy. In addition to the above described paper-bound books, a new cloth bound edition of *'FROM THE HILLS TO THE HUDSON'*, a history of the Paterson & Hudson River, and Paterson & Ramapo Railroads (both are now an important part of the New Jersey lines of the Erie Railroad) has been prepared. This well illustrated book may be obtained at $4.00 per copy. Orders for any of the books should be addressed to Mr. Halsey L. Tilton, Treasurer, 761 West Inman Avenue, Rahway, New Jersey.

RAILROADIANS OF AMERICA

The **RAILROADIANS OF AMERICA** *is a nationwide, non-profit association of those whose avocation is the study of railroading, both past and present day. We believe in the preservation of railroad memorabilia, and in the dissemination of railroad history and factual data to all interested. In addition to the books published in New York, and the quarterly* **"TRAIN SHEET"** *which is sent to all members, the San Francisco Branch has issued annually for several years attractive three-color commemorative calendars featuring long-vanished railroads, including maps and photos as well as data relating to them. Regular monthly meetings are held by the San Francisco Branch, and to which the interested public are invited. Anyone interested in the aims and activities of this society are invited to address the following officers:*

NILES G. BERGENHOLTZ, *Secretary*
1416 Munn Avenue
Hillside 5, New Jersey

FREDERIC SHAW, *Vice President*
4 Third Street
Sausalito, California

THE

BILLERICA & BEDFORD TWO-FEET GAUGE R. R.

This road, while it was in operation, attracted a great deal of attention from the fact of its being the first two-feet-gauge railroad built in this country, and from its low cost, which was expected to be only $6,000 per mile when the road was completed. A full account of it, with a complete description and illustrations of its location and construction, and of the rolling stock used on it will therefore be of interest:

The road and its rolling stock were planned by Mr. Geo. E. Mansfield, of Boston, Mass., and to him belongs the credit for the successful manner in which the whole project of constructing the road was carried out.

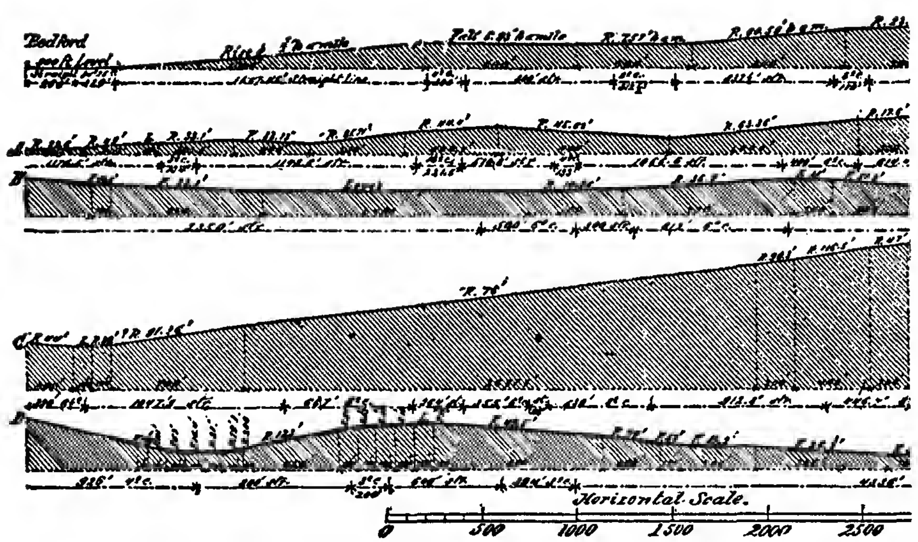
The road extends from Bedford, a station on the Middlesex Central Railroad of Massachusets, and not far from Lexington, the site of the first battle of the Revolution, northward 8.63 miles to North Billerica, a station on the Boston, Lowell & Nashua Railroad. It passes through ordinary New England farming country, with a number of villages on the line. At South Billerica there is a manufactory of leather machinery and glue works, which are expected to contribute some business to the road. At Bedford Springs there is a summer hotel, which will attract some travel to it.

Fig. 1 is a map showing the location of the line, and fig. 2 a profile showing its grades. The following description of the engineering features of its location have been kindly furnished us by Mr Hiram W. Blaisdell, the Chief Engineer who located the line:

"The location of seven-eighths of the road is through a rough and rocky district, hard pan and cemented gravel predominating. The remainder of the line is through a sandy plain which requires but little grading exclusive of ditching and ballasting. Taken as a whole, the line may be said to run through an unusually difficult section, where a standard gauge would cost heavily.

"The deepest rock cut is on the incline south of Billerica Centre, and is 9 ft. deep for a short distance. To have avoided this ledge would have required a 120-ft. grade where there is a 75-ft. grade.

"The steepest grade is on the line between North Billerica and Billerica Centre, and is $158\frac{4}{10}$ ft. per mile. This grade is nearly three-quarters of a


Bedford
Horizontal Scale.
0
500
1000
1500
2000
2500

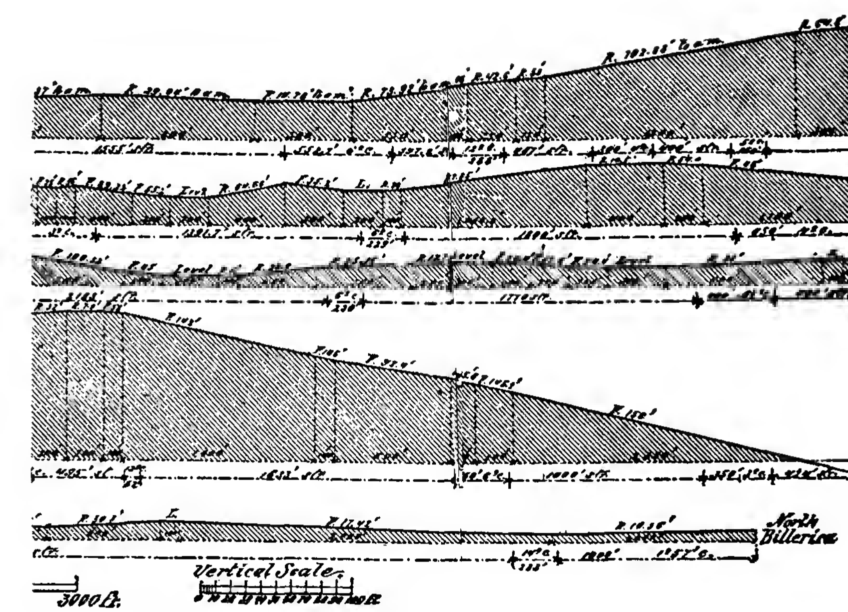

North
Billerica
Vertical Scale.
3000 ft.

Fig. 2.

mile long. The fall from Billerica Centre to North Billerica is 129 ft., giving an average grade of $60\frac{2}{10}$ ft. per mile. There are ninety different grades in the line.

"The entire road is to be ballasted with sand or gravel to the depth of

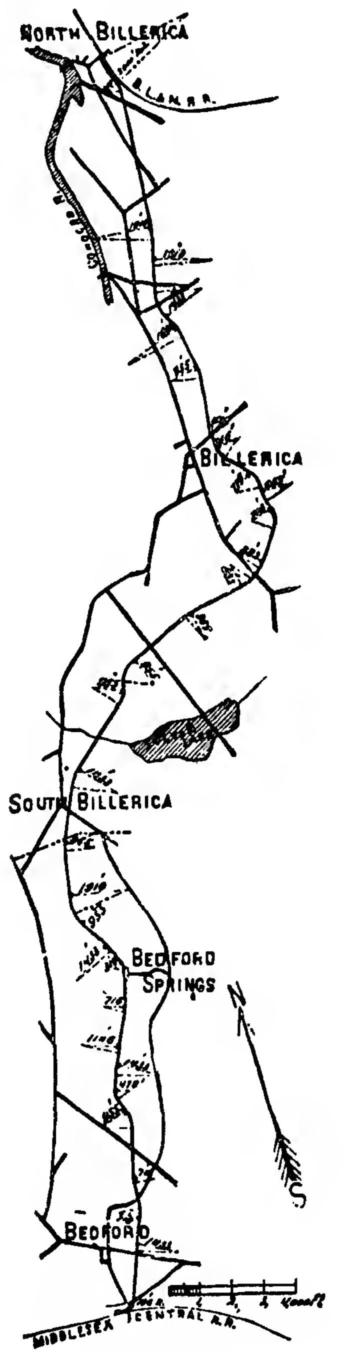


Fig. 1.

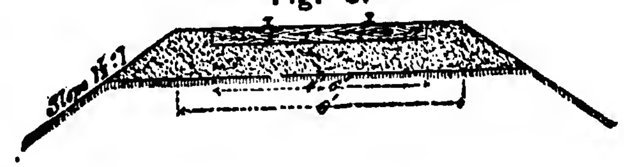
12 in. below the tops of the ties. The road-bed is 6 ft. wide at grade on fills, and 10 ft. wide in cuts. Fig. 3 represents a cross-sectionof a fill, and fig. 4 of a cut.

"The sharpest curve on the main line is $319\frac{6}{10}$ ft. radius (the elevation of outer rail for this curve is $3\frac{1}{8}$ in.); on the Y at Bedford, 129 ft. radius.

The locomotive is now running on a 250-ft. curve with perfect ease.* The engine and train will be turned on a Y at the Bedford station. Turn-tables will be used at Billerica Centre and North Billerica.

"The culverts in deep fills are either open or of cement pipe, while those in shallow fills, when they can be easily replaced, are made of pine lumber. There are six open culverts of from 8 to 15 ft. span, one pile bridge 140 ft. long, and 10 cattle-ways. The mason-work is first-class

Fig. 3.



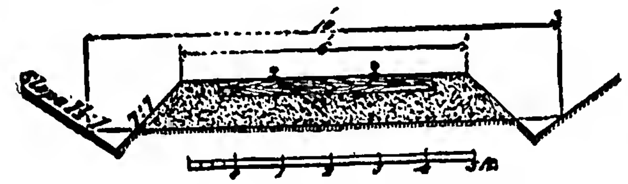


Fig. 4.

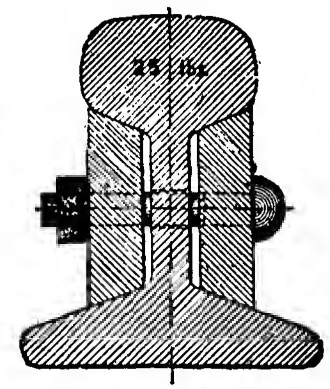


Fig. 5.

rubble masonry. The right of way generally adopted is 25 ft. There will be about 600 cubic yards of rock-work and 30,000 cubic yards earth excavation, including ballast. †

"The culverts and bridges are calculated to sustain a safe centre load of 10 tons, the factor of safety used being as high as 7 in all structures.

"The dimensions of timber used are as follows :

For	6-ft.	culverts	two timbers	8 × 10 in.
"	8 "	"	"	10 × 12 "
"	12 "	"	"	10 × 14 "
"	15 "	"	"	12 × 14 "

" 25 " spans for pile bridge two timbers 10 × 22 in. or its equivalent in two pieces firmly bolted together."

The track follows the surface of the ground as closely as possible, and,

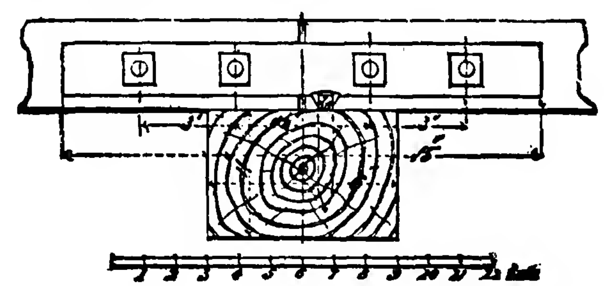


Fig. 6.

therefore, the line is an almost continuous series of grades and curves, as shown in the map and profile. The total amount of grading was 43,000 cubic yards, with 542 cubic yards of loose rock and 640 cubic yards of solid rock. The price at which the earth-work, including the ballast, was contracted for was 35 cents per cubic yard, and the rock work was $1.50 per yard.

* Sinc the above was written the Y at Bedford was completed, and the engines run over it without any difficulty.

† This estimate was somewhat exceeded, as stated hereafter.

The rails, of which a half-sized section is shown in fig. 5, are of iron, 30 ft. long and weigh 25 lbs. per yard, and cost in Boston $38 per ton. They are fastened together by ordinary fish-plates, a side view of which is shown in fig 6. These are 15½ in. long, and a pair of them weigh 5⅛ lbs. The bolts are ½ in. diameter and 2¼ in. long. One bolt and nut weighs 4½ ounces. The fish-plates cost two cents per pound, and the bolts and nuts four cents. The spikes are $\frac{7}{16}$ in. square and 3½ in. long under the head. There were 600 of these spikes to a keg, each keg weighed 150 lbs., and it took 16 kegs per mile, which cost 2¾ cents per pound.

The cross-ties were made of sawed lumber, and, as shown in figs. 3 and 4, were 4 ft. 6 in. long, 6 in. wide and 4 in. thick, and cost 12 cents each.

LOCOMOTIVES.

The locomotive engines used on the road were built by the Hinkley Locomotive Works, of Boston, and are constructed on the plan proposed and patented by Mr. M. N. Forney. The designs were, however, worked out by Mr. F. D. Child, the late Superintendent of the works where they were

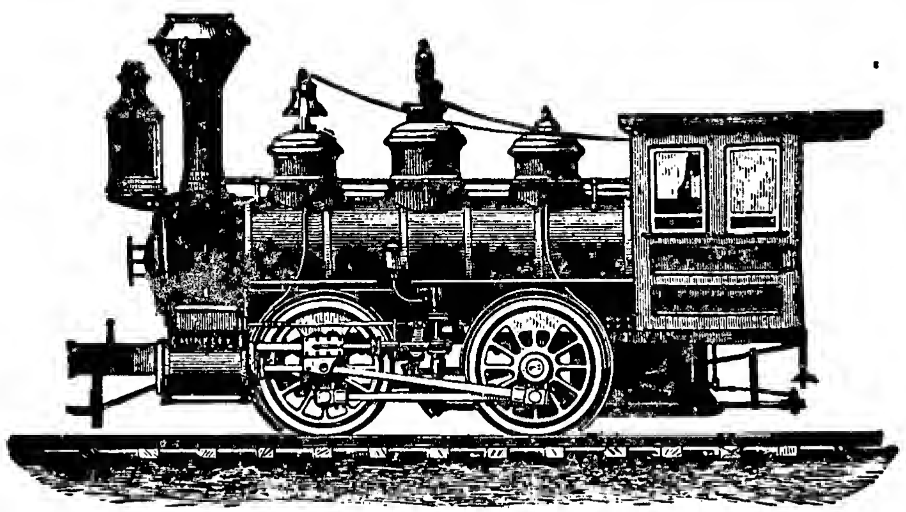


Fig. 7.

built. This was done with so much skill and good taste that the engines have excited general admiration, and since they have been put into service they have worked in the most satisfactory manner.

Although the objects aimed at in the design of this engine have been frequently described, a few words regarding it may not be amiss here.

It is a fact well known by all experienced railroad engineers, that a four-wheeled switching engine like that represented in fig. 7. which has the whole weight of the boiler and machinery on the driving-wheels, and weighing say twenty tons, will pull as great a load as an eight-wheeled or "American" engine like that shown in fig. 8, and weighing 50 per cent. more, or thirty tons. The reason for this is that about one-third of the weight of the latter is on the leading truck, whereas the whole weight of the four-wheeled engine is on the driving-wheels.

The question would then very naturally arise why not use the four-wheeled locomotive for ordinary traffic? The objection to doing so is that the wheel-base of such an engine must necessarily be comparatively short, and therefore it is unsteady when running at a high rate of speed

or on a rough track. If it be asked why the wheel-base might not be lengthened and the whole weight of the engine still retained on the driving wheels, it may be said that in order to utilize the whole weight on the wheels, it is necessary to connect them to each other by cranks and rods, so as to revolve together. The crank-pins must, then, always be the same distance apart, and the axles, therefore, be held in a position parallel to each other. But if a pair of wheels attached to an axle roll on a curved track, the position of the centre line of the axle should conform to that of the radii of the curve, in order that the wheels may always be parallel to, and roll in a line with, the rails. If the axles are not radial to the curves, the flanges of the wheels will come in contact with the rails at an angle, and the abrasion of both is in proportion to the inclination of the one to the other. If two or more pairs of wheels are connected together by cranks and rods, and the axles are consequently attached to a frame and held rigidly parallel to each other, and the wheels

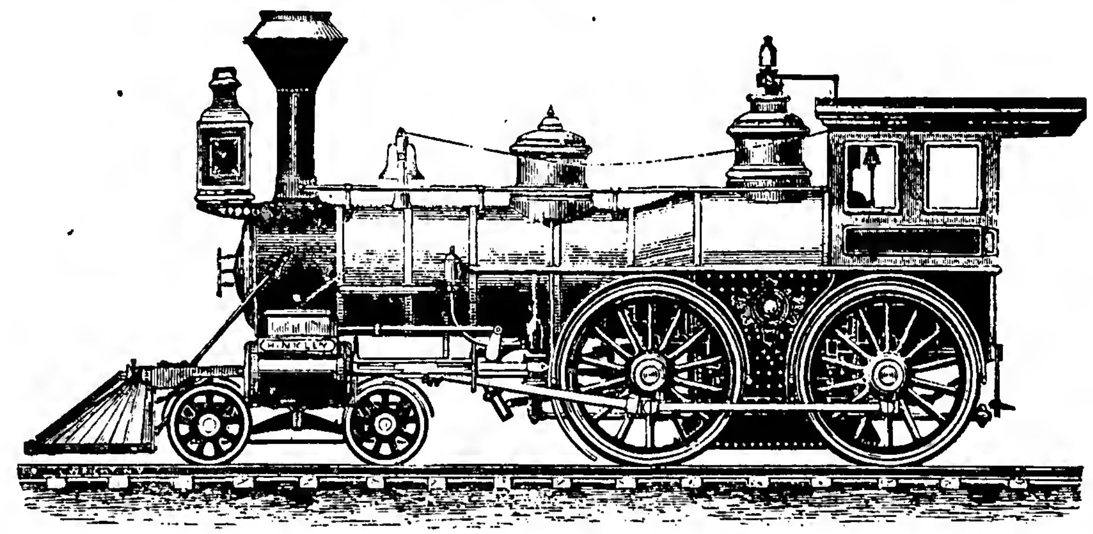


Fig. 8.

are rolled on a curved track, it is obvious that *all* the axles, being parallel, cannot conform to the radii of the curve. The greater the distance apart of the axles, the more will be their divergence from their radii and the greater the inclination of the wheels to the rails. ‡

Consequently, if the wheel-base of a locomotive is lengthened, by plac-

‡ This can easily be demonstrated mathematically. Suppose *m n* and *m′ n′*, fig. 9, to be a curved track, and *g o* a radius of the curve, and *a b* and *c d* two pairs of wheels and axles—the latter parallel to and equidistant from the radius *g o*. Now, in order that the wheels *a* and *c* may run on the same right line or track, they must be in the same plane to which the axles would be perpendicular. If, therefore, from *a*, the point of contact of the wheel with the track, a line, *a c*, be drawn perpendicular to *a b*, this line will be in the plane of the two wheels, and be perpendicular to their axis and to *g o*. From *a* and *c* draw the radii *a o* and *c o*, and at *a* draw a line, *h e*, tangent to the curve *m n*, and therefore perpendicular to the radius *a o*. Now, as the circumference of a circle is perpendicular to its own radii at the point where they intersect, therefore the tangent *h e* and the curve must coincide at the point *a*, and therefore the angle which the line *a c*, lying in the plane of the wheel, makes with the tangent *h e* must be the same angle that the wheel makes with the curved track.

Now, in the triangle *a f o* the angle *a f o* is a right angle; therefore the angle $o\,a\,f + f\,o\,a$ = a right angle. But as the angles $o\,a\,f + f\,a\,e = e\,a\,o$, which is also a right angle, therefore *f a e* must be equal to *f o a*. This latter angle is measured by the arc *a g*, which is one-half the arc subtended by the chord *a c*, which equals the distance between the axles; and as the length of an arc increases with the length of its chord, therefore the greater the distance between the axles the greater will be the angle *f o a* and *f a e*, which is the angle of the wheel to the rail.

ing the driving axles far apart, the injury to the rails on curves by the abrasion of the flanges of the wheels, and the danger of running off the track, will be increased. If the axles are placed near together, the wheel-base will be short, and at high speeds or on a rough road the motion will be inconveniently and dangerously unsteady. This is illustrated by an ordinary horse-car, the wheels of which in order to pass around short curves easily are placed near together, and it therefore acquires a peculiar leaping motion in running rapidly over frogs, switches, or other

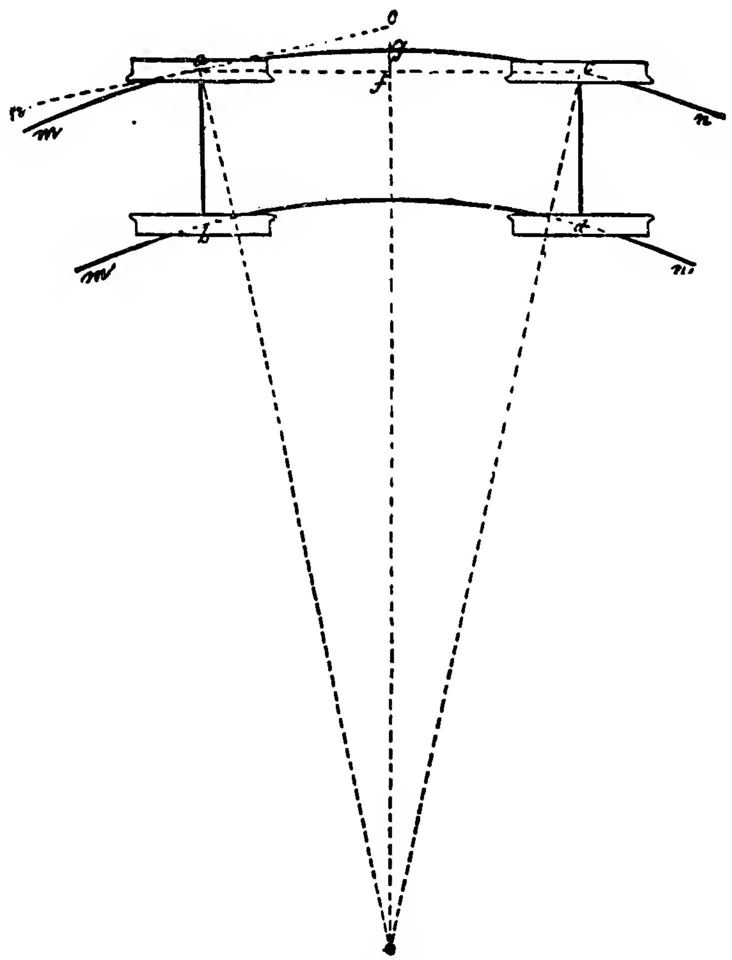


Fig. 9.

uneven places on the track. The speed of both street-cars and switching locomotives is, however, comparatively slow, so that their unsteadiness is of little consequence. At higher speeds it would become dangerous, and for this reason four-wheeled locomotives are seldom or never used on ordinary steam roads in this country for any other purpose excepting for switching cars or other slow traffic.

In order to obviate this evil and to secure the desired steadiness of locomotives by providing a long wheel-base, while at the same time avoiding the evils attending the use of axles placed far apart and held rigidly parallel to each other, "bogies" or trucks, shown in fig. 8, have come into almost universal use in this country for all locomotives intended to run at high rates of speed. They consist of one or two pairs of wheels and

axles attached to a separate frame, which is connected to the locomotive by a centre-pin, which allows the whole truck to vibrate or turn around the pin—similar to the movement of the front axle of a common road-wagon or carriage; and, consequently, the wheels and axles of the truck can adjust themselves to the curvature of the track, no matter what the length of the wheel-base may be.

A plan of the wheels, arranged in this way, is shown in fig. 10—in which *a*, *b*, *c*, *d* are the driving-wheels, and *e*, *f*, *g*, *h* the truck-wheels, *o* the centre about which the truck turns, and *m n m′ n′* a curved track. It is apparent from the diagram that by turning on the centre-pin the truck can adjust itself to the curvature of the track, and the wheels of the truck being comparatively near together, its wheel-base is short, and therefore the angle of the wheels to the rails is very small. The engine is therefore guided by wheels which are at all times very nearly parallel, to the rails. The abrasion of the latter by the wheel-flanges, and the danger of getting off the rails are consequently very slight.

As has been stated, in such engines the truck carries about one-third the weight of the locomotive, lessening thereby the load on the driving-wheels, and in the same proportion the capacity of the engine for drawing

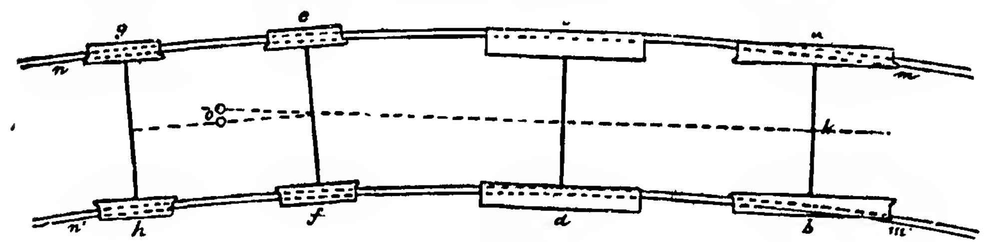


Fig. 10.

loads. Therefore, when a truck is used in the ordinary way one-third of the adhesive weight of the locomotive is lost. Railroad engineers in this country have decided, however, that the increased steadiness and ease of passing curves gained by using a long wheel-base and a truck for the leading wheels compensates for the loss of adhesive weight, and the great majority of locomotives now in use here have such trucks in front, which act as guides, and which carry one-third or more of the weight of the engine.

Some years ago Mr. Forney devised and patented the plan which has been adopted for the engine for the Billerica & Bedford road, and is shown in the full-page plate and the other engravings, by which all the weight of the boiler and machinery is carried on the driving-wheels, just as it is carried by ordinary four-wheeled engines, represented by fig. 7; but by extending the frames backward or beyond the fire-box, as shown in the perspective view and the other engravings, room was provided for carrying the water or fuel, or both, on this frame, and a truck was then placed underneath it to carry the weight of the water and fuel, which of course, made it possible to dispense with a tender, and at the same time the weight of fuel, water, water-tank, etc., served to keep the truck on the track. In this way the whole weight of the boiler, machinery, etc., which is *permanent* or *unchangeable*, is carried on the driving-wheels, where it is available for adhesion, and the weight of the water or fuel, or

both, which is variable, is on the truck. Much importance is assigned to this latter feature. If the weight on the driving-wheels consists partly of that of the fuel and water carried, then the adhesion of the engine will be reduced as these are consumed. If, however, the fuel and water are carried on the truck and the weight of the boiler and machinery on the driving-wheels, then the adhesion is due to the *permanent* weight, and is therefore *constant*, while at the same time the wheel-base is sufficiently long and flexible to give the requisite steadiness and to pass around curves with ease.

It has been explained that with a long wheel-base it is desirable to have a truck which can turn on a centre-pin, and adjust itself to the curvature of the track to guide the engine. For this reason Mr. Forney proposed to run locomotives of his plan with the truck in front, or the reverse direction of that in which locomotives are usually run, and this recommendation has been adopted in the construction and in operating the engines for the Billerica & Bedford Railroad. There are no valid objections to doing so. Those which are urged against it are usually only prejudice, and no difficulty at all has been encountered in running the locomotives in the manner proposed, although on the road named they are run either way that may be most convenient.

There are, however, some important advantages gained in running such engines with their trucks in front or with the chimneys behind.

With the chimney behind and next the car, the smoke and gas from the fire are thrown up above the train, and consequently do not enter the cars so much as they do if the chimney is in front. The reason for this is that the cab, in moving rapidly through the air, creates a partial vacuum behind it, to which the surrounding air has a tendency to flow, and when the chimney is in front the escaping gas and smoke from the top of it are drawn to this vacuum, which is in front of the first car. When the chimney is next the car this does not occur, or, at least, not to nearly the same degree, because the smoke then escapes behind this rarified air produced by the movement of the cab, and consequently the cars, as it were, run under the escaping gases, which are then drawn toward the partial vacuum formed behind the last car of the train. §

In the next place, the truck being some distance forward of the fire-box, the position of the engineer and fireman is necessarily between the truck and driving-wheels, which is the steadiest part of the locomotive, and therefore the most comfortable place to ride: and as there is no flexible joint in the frame between the boiler and tank, as between ordinary engines and tenders, the cab can be shut up in cold or stormy weather, affording complete protection to the engineer and fireman. In summer the motion of the locomotive carries the hot air from the boiler *out* of the cab instead of into it, as is the case when the boiler is infront. The cab is thus warmer in winter and cooler in summer. Reversing the position and motion of the boiler necessarily brings them in front of it, and the dome and smoke-stack behind them. This leaves a perfectly unobstructed view of the track in front, and *the smoke and escape steam are*

§ Mr. Mansfield, the General Manager of the Billerica & Bedford Railroad, writes: "We find that our smoke-stacks being near to the car, there is no vacuum, and all cinders are thrown over the train, so the passengers receive none."

behind the engineer, and therefore will not obscure the objects in front of him.

The following are the principle dimensions of these engines :

Gauge of road	2 ft.
Diameter of cylinders	8 inches.
Stroke of pistons	12 "
Diameter of driving-wheels	30 "
Total wheel-base	13 ft. 0 in.
Driving-wheel base	3 " 6 "
Weight of engine with fuel and water	23,750 lbs.
Weight on driving-wheels	14,350 "
" " truck	9,400 "
Capacity of tank	400 gals.
Inside diameter of front end of boiler	30 in.
Diameter of dome	18 "
Length of fire-box inside	30 "
Width " " " "	27¾"
Height " " " "	37 "
Water space	2½"
Number of tubes	70
Diameter " "	1¾"
Lenght " "	6 ft. 7 "
Thickness of iron plates in shell of boiler	5-16"
" " steel " " sides and back of fire-box	¼"
Thickness of steel tube-sheet	⅜"
" " " crown	¼"
Size of steam-ports	6 × ¾"
" " exhaust "	6 × 1¾"

The driving-wheel tires are of steel ; the main pair are flat or without flanges and 5½ in. wide ; the other pair have flanges and are 5 in. wide.

Thickness of tires	2 in.
Diameter of wheel centres	26 "

Size of journals, 4 in. diameter × 4 in. long
Truck frame to be of wrought-iron forged solid, the jaws of cast-iron.
Diameter of chilled cast-iron truck wheels, 18 in.
Truck axles to have outside journal-bearings 5 in. long × 2⅝ in. diameter.
Engine to have one No. 3 and one No. 4 Mack's injectors.

A feature in these engines which is worthy of notice is the width of fire-box. With the ordinary methods of construction employed in this country, the fire-boxes on all engines, but especially on those for narrow-gauge roads, must be very much contracted. If the usual plans were followed in engines for a 2-ft. gauge road, the fire-boxes would necessarily be contracted still more than on a 3-ft. gauge road. For this reason, in designing these engines, the method of construction was adopted which is shown clearly in the plan, fig. 13. It will be seen that the wheels are placed entirely beyond the fire-box, so that it can be spread out as wide as may be desired, and the frames are then abutted against the fire-box and attached to it with an expansion joint, so as to allow the boiler sufficient room for the movement which is due to expansion and contraction from heating and cooling. The frames which support the tank and which rest on the truck, consist of flat plates strengthened with angle iron, and are bolted to the sides of the fire-box. While this method of construction is admissible for an engine of so small a size it could not perhaps be recommended for engines of a larger size for the standard gauge. It will be seen, however, that it gives all the width of fire-box that is needed, an advantage which, it has been claimed, can only be realized on narrow-gauge roads by the use of the double-truck engines.

Of the working of these engines, Mr. Mansfield, the General Manager of the Billerica & Bedford road, wrote Sept. 9, some time after they were received :

"Everything is working splendidly on the road, and the Forney engine

is a complete success with us and is admired by every one. They are beginning to see its true principles, if it does run backward, as they call it. The engineers like it better every day."

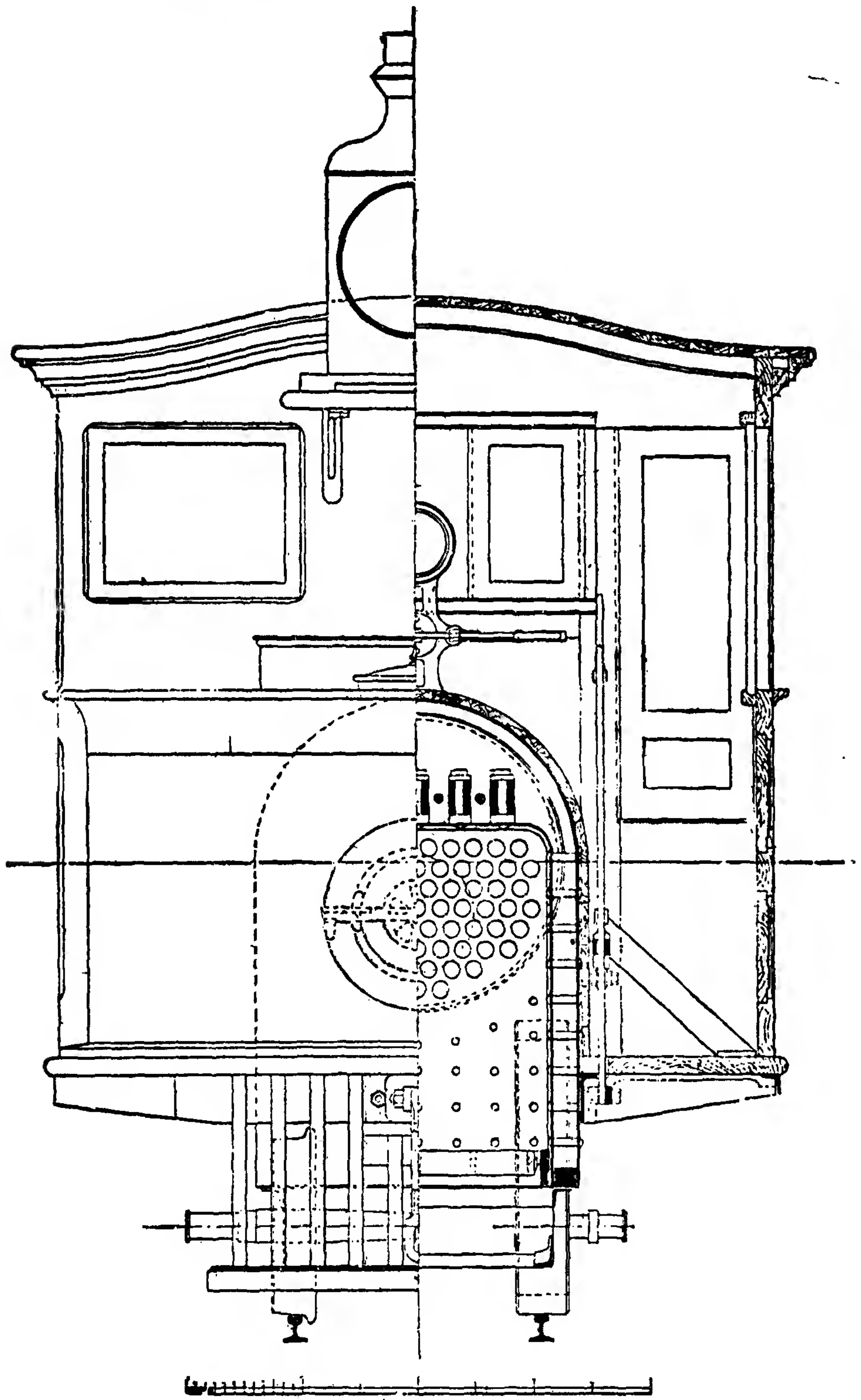


Fig. 14.

Elevation of Front End of Locomotive. *Section through Fire-Box.*

On Oct. 22, he writes :

"The new engines on the 24-in. gauge are a double success. They pass the curves of the Y, 127 ft. radius, with ease. The engineers say they are

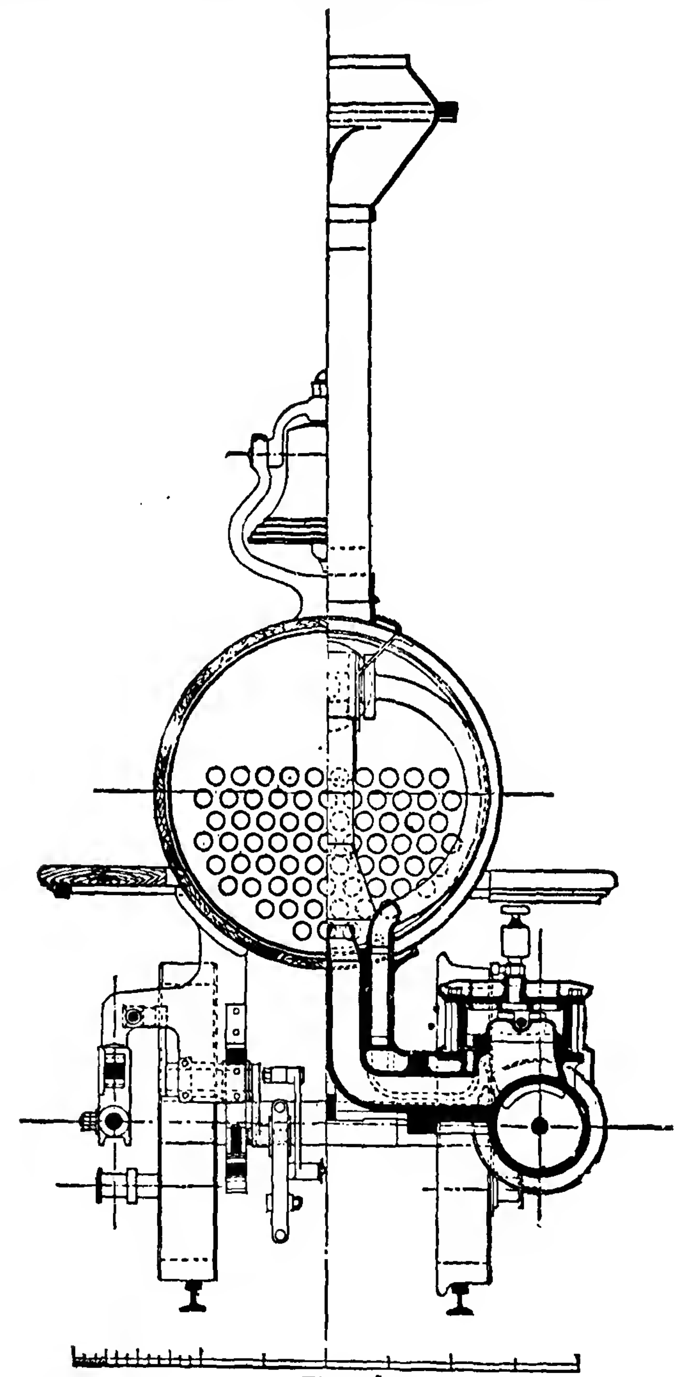
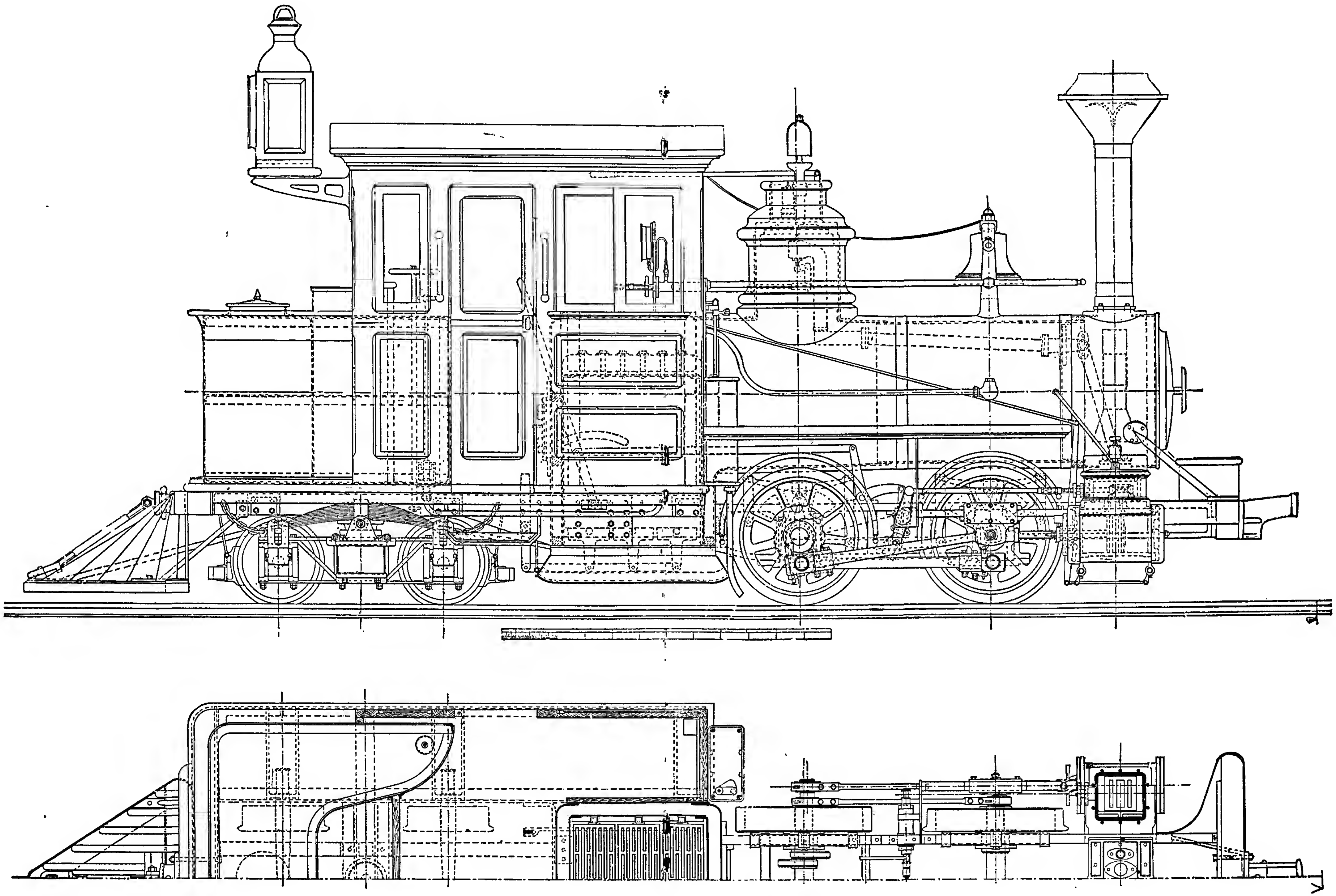


Fig. 15.

Section through Guide Bar. *Section through Centre of Cylinder and Smoke-Box.*

the smartest and most perfect engines in everything they ever pulled the throttle on. They make more steam than is wanted and use but little coal. We have been burning hard coal the past week, and have made a speed of thirty-five miles per hour on our rough track. The side oscilla-



"FORNEY" TANK LOCOMOTIVE FOR THE BILLERICA & BEDFORD (2-ft. Gauge) RAILROAD

Built by the Hinkley Locomotive Works, Boston, in 1877

tions are done away with entirely. We ran passenger trains four days last week with the greatest satisfaction, the cars riding smoothly and with perfect ease and no side oscillations, which is noticed by all who speak of it. We have never had any hot boxes on any of the cars since running, or on the locomotives. As to economy see the following:

"Last week we ran a train 72 miles each day at a cost of 13 cts. per mile. This includes all help, fuel, oil and waste, using less than ¾ ton of coal.‖

"The weight of train including engine was 23½ tons, the weight of cars 11½ tons, with seating capacity for 100 passengers, which number we carried on some trips. One of the cars was a combination baggage and express car. There is one grade of 158 ft. per mile, two of 100 ft. one-half mile each long, and numerous other grades of 40 to 90 ft.

"The cost on the Middlesex Central Railroad which we feed into at Bedford, is 60 cents per mile,¶ and it has only one grade of 60 ft."

On Nov. 28, he writes:

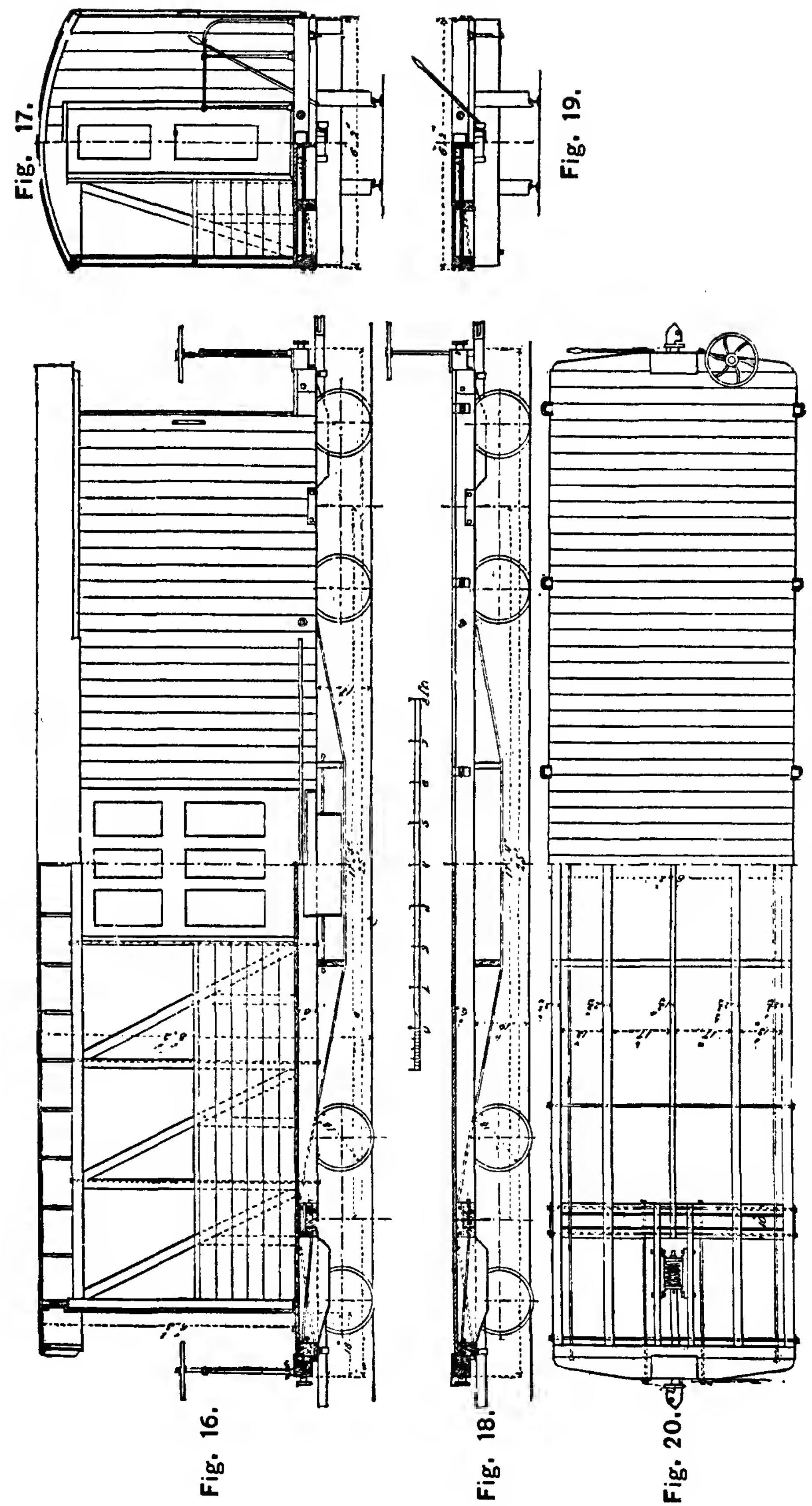
"The Forney locomotive, running with the truck in front and the smoke-stack next to the cars, does not throw any cinders or smoke on the face or sides of the cars, the smoke and cinders, being carried with the current of air above the train, are thrown behind it, thus giving no annoyance to passengers. We consider this plan of locomotive the best type for one which must combine power and speed with stability, so necessary to overcome steep grades and sharp curves. On our experimental trip in the two-foot-gauge road they have pulled three passenger and one box car up a grade of 158 ft. to a mile at a speed of about 18 miles per hour with apparent ease. We believe them to be able to do much better yet. They enter our sharpest curves (of 127 ft. radius) so easily that the change of motion is hardly felt on the foot-board."

A careful examination of the engravings will show how skillfully these engines have been designed, and the above letters indicate that they work with entire success.

FREIGHT CARS.

The engravings show the construction of the box and flat freight cars, the trucks for same, and the excursion cars of this road. The latter are the same as the flat cars excepting the seats and the roof or awning over the seats. The box and flat cars are 25 feet long over the body and 6 ft. 2 in. wide, or more than three times the width of the gauge. The weight of the box car is 5,600 lbs. and the capacity 16,000 lbs. The flat cars weigh 4,500, with the same capacity as the box-car. The excursion cars weigh 5,500 lbs., and have seats for 55 passengers. The road has one box-car, six flat cars and two excursion cars. They are all equipped with the Miller coupler. The drawings represent their construction so clearly that no further description is needed, excepting perhaps to enumerate the different engravings. Fig. 16 is a side and fig. 17 an end elevation, and fig. 20 a plan of a box freight car. Fig. 18 is a side and fig. 19 an end elevation, and fig. 20 a plan of a flat car, the plan being the same for both flat and box-cars. In all these views the outside is shown

* This would be at the rate of about 100 miles per ton of coal.
† The Middlesex Central road is of 4 ft. 8½ in. gauge with the ordinary rolling stock.



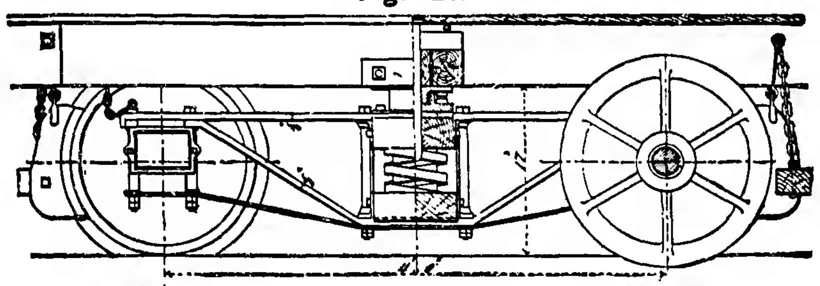
BOX AND FLAT CARS FOR THE BILLERICA & BEDFORD RAILROAD.

by the right half of the engraving and the framing by the left half. Fig. 21 is a side view, fig. 22 a plan, and fig. 23 an end view of the freight-car truck, which is also used under the excursion car. Fig. 24 is a side view, fig. 25 is an end view, and fig. 26 a plan of the excursion car.

PASSENGER CARS.

Fig. 27 represents a longitudinal section of the passenger car;

Fig. 21.



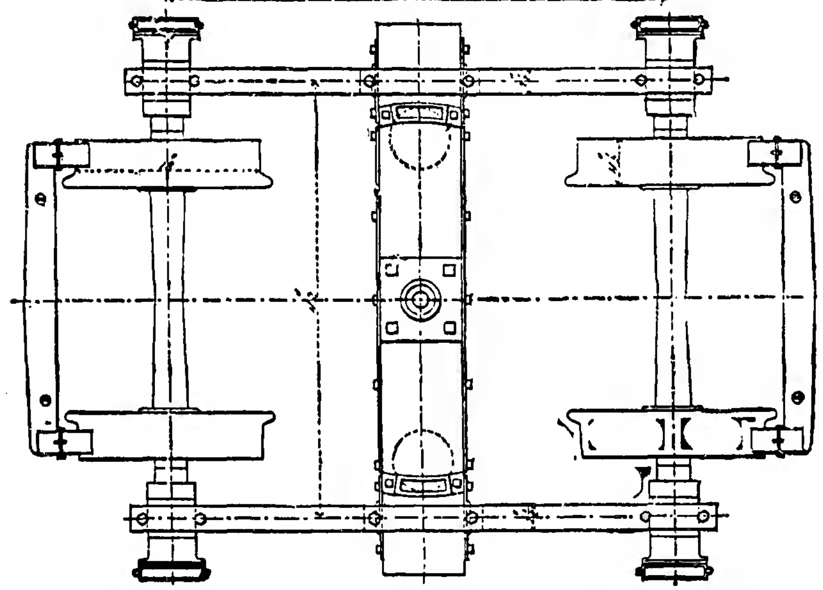


Fig. 22.

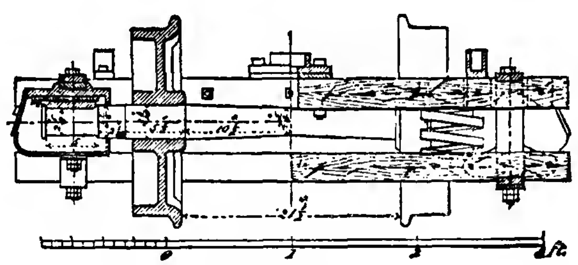


Fig. 23.

FREIGHT AND EXCURSION CAR TRUCK.

fig. 28, a similar section of a combination baggage and express and passenger car; fig. 29, a plan of the latter; fig. 30, a transverse section; and fig. 31, an end view of these cars. From the plan and transverse sections it will be seen that the seats are arranged as in ordinary cars, excepting that each has room for only one instead of two passengers. They are placed 28½ in. from centre to centre. This is considerably

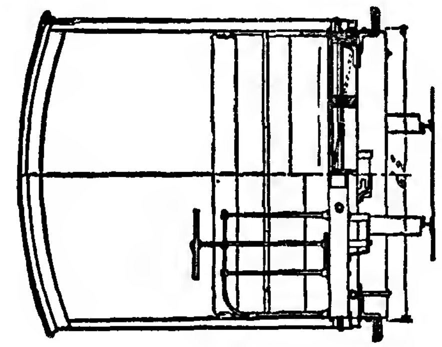


Fig. 25.

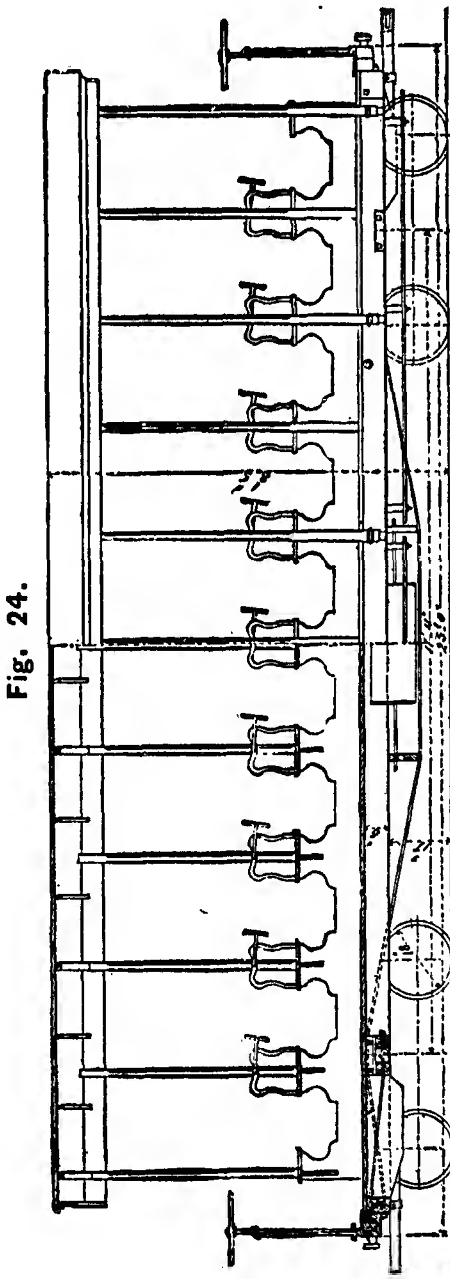


Fig. 24.

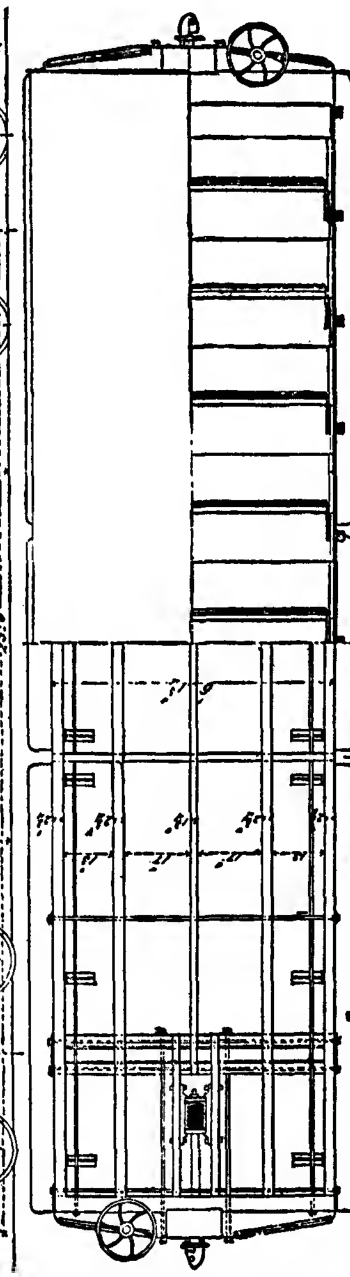


Fig. 26.

EXCURSION CAR FOR THE BILLERICA & BEDFORD RAILROAD.

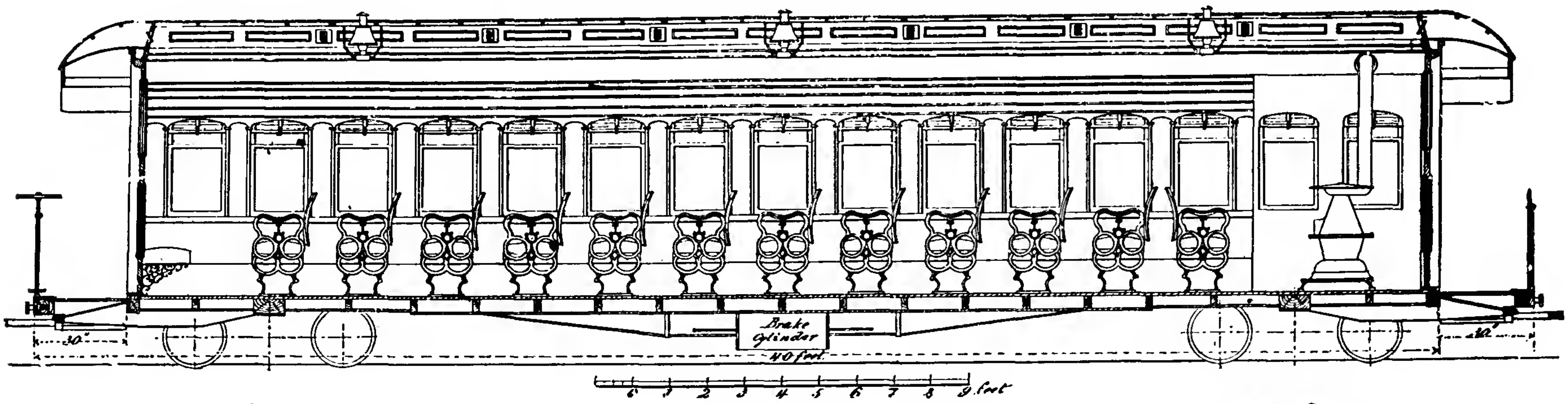


Fig. 27.

Fig. 31.

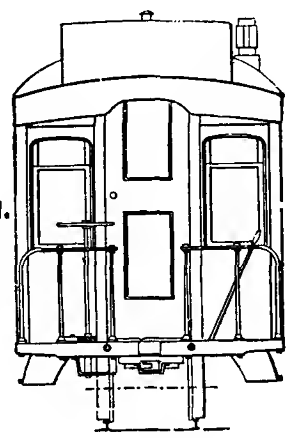
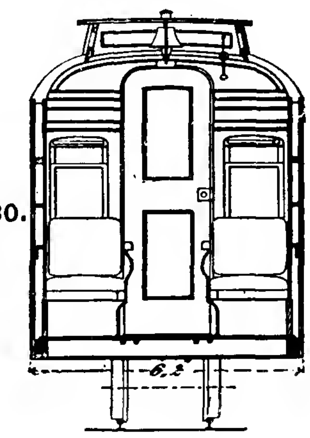


Fig. 30.



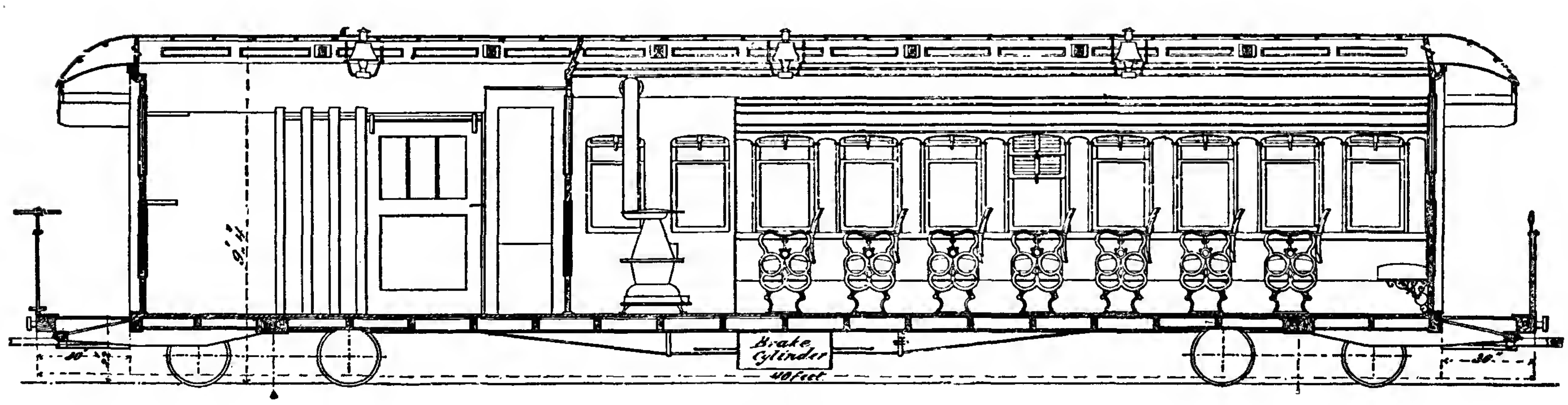


Fig. 28.

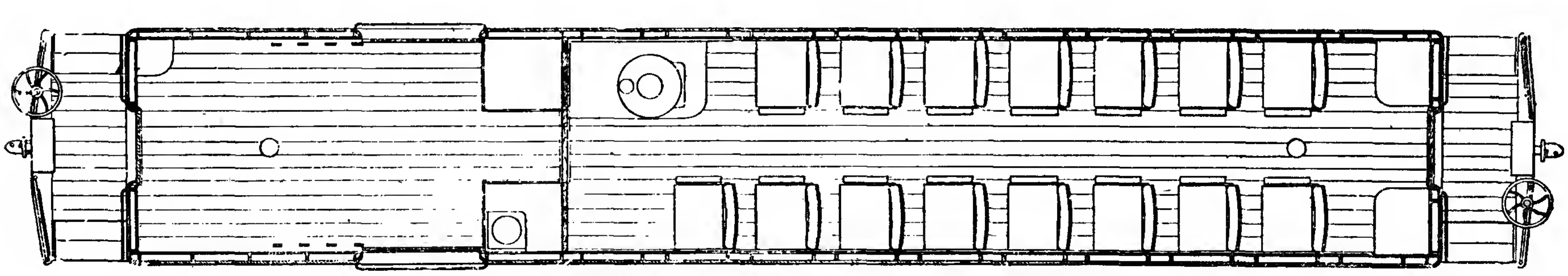
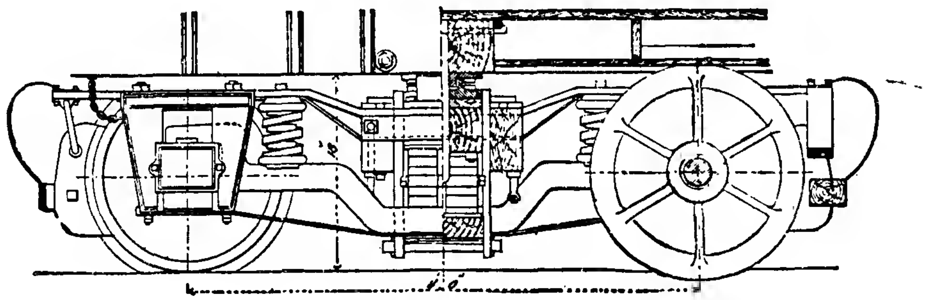


Fig. 29.

PASSENGER AND COMBINATION CARS FOR THE BILLERICA & BEDFORD (2 feet gauge) RAILROAD.

closer than on ordinary railroads, on which the seats are usually from 32 to 34 in. apart. The cars are 35 ft. long over the bodies, and 40 ft. from

Fig. 32.



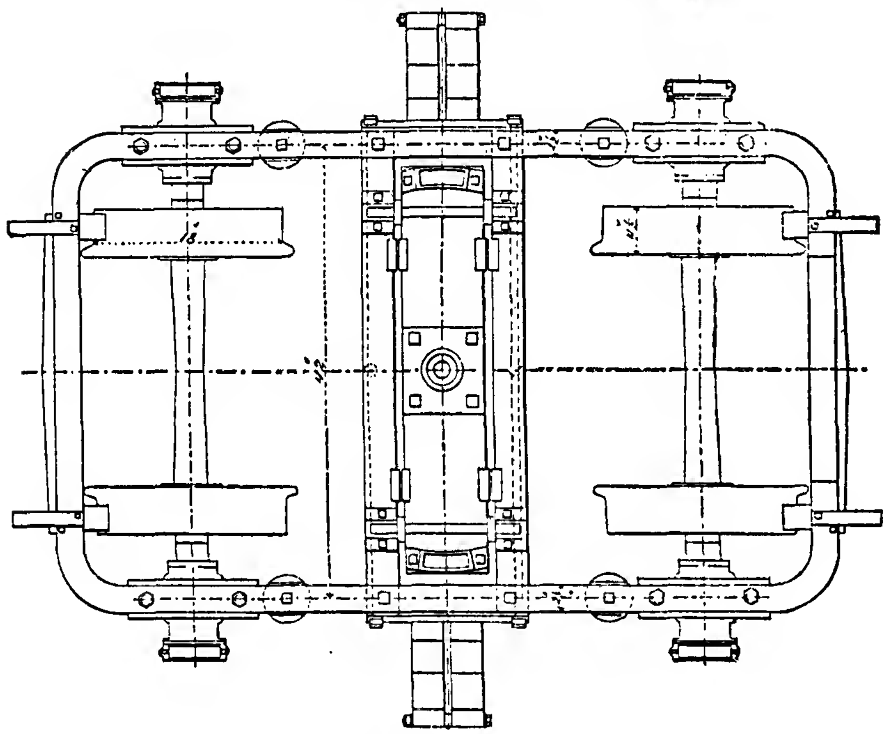


Fig. 33.

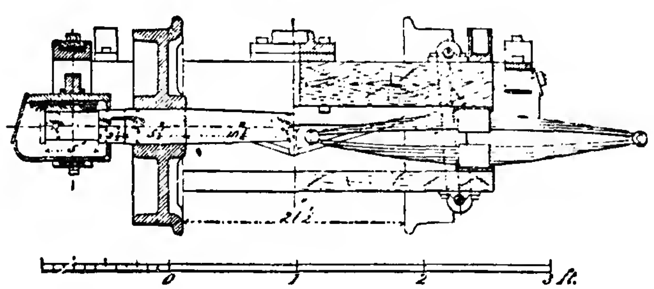


Fig. 34.

TRUCK FOR PASSENGER AND COMBINATION CAR.

end to end of the platforms, and 6 ft. 2 in. wide outside. The wheels are 18 in. in diameter, and spread 4 ft. from centre to centre.

Fig. 32 is a half-elevation and half-longitudinal section: fig. 33, a plan: and fig. 34, transverse sections through the axle and bolster of the truck.

The passenger car weighs 9,000 lbs., and seats 30 passengers. The combination car weighs the same, and seats 20 passengers, but with a compartment for baggage and express matter. Each truck, like those illustrated, which are used under both passenger and combination cars, weighs 1,748 lbs.

The freight and passenger cars were built by the Ranlet Car Manufacturing Company, of Laconia, N. H.

FROGS.

The frogs used on this road are represented by fig. 35, and are known as Bryant's steel rail frogs. They were manufactured by the Worcester Frog & Switch Company, of Worcester, Mass. Their construction is shown very clearly by the engravings.

SWITCHES.

The majority of the switches in use on the Billerica & Bedford Railroad are also made under Mr. E. H. Bryant's patents by the same company, with the addition of a *lock lever* devised by Mr. A. H. Howland. The engrav-

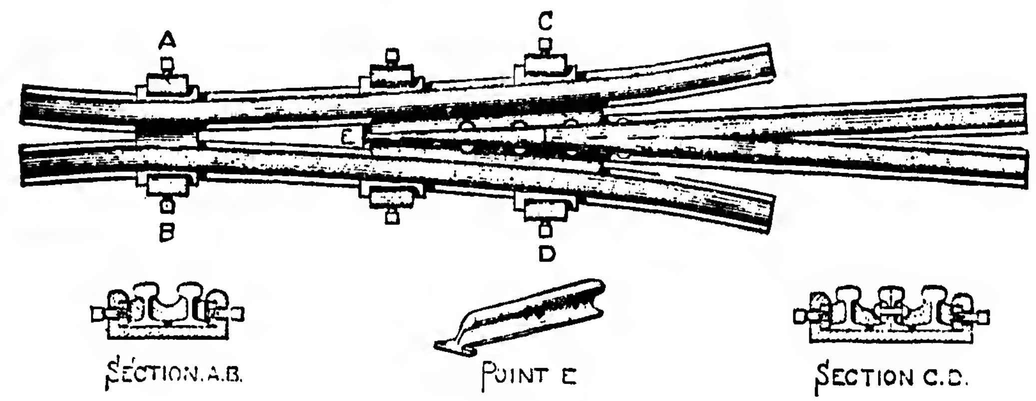
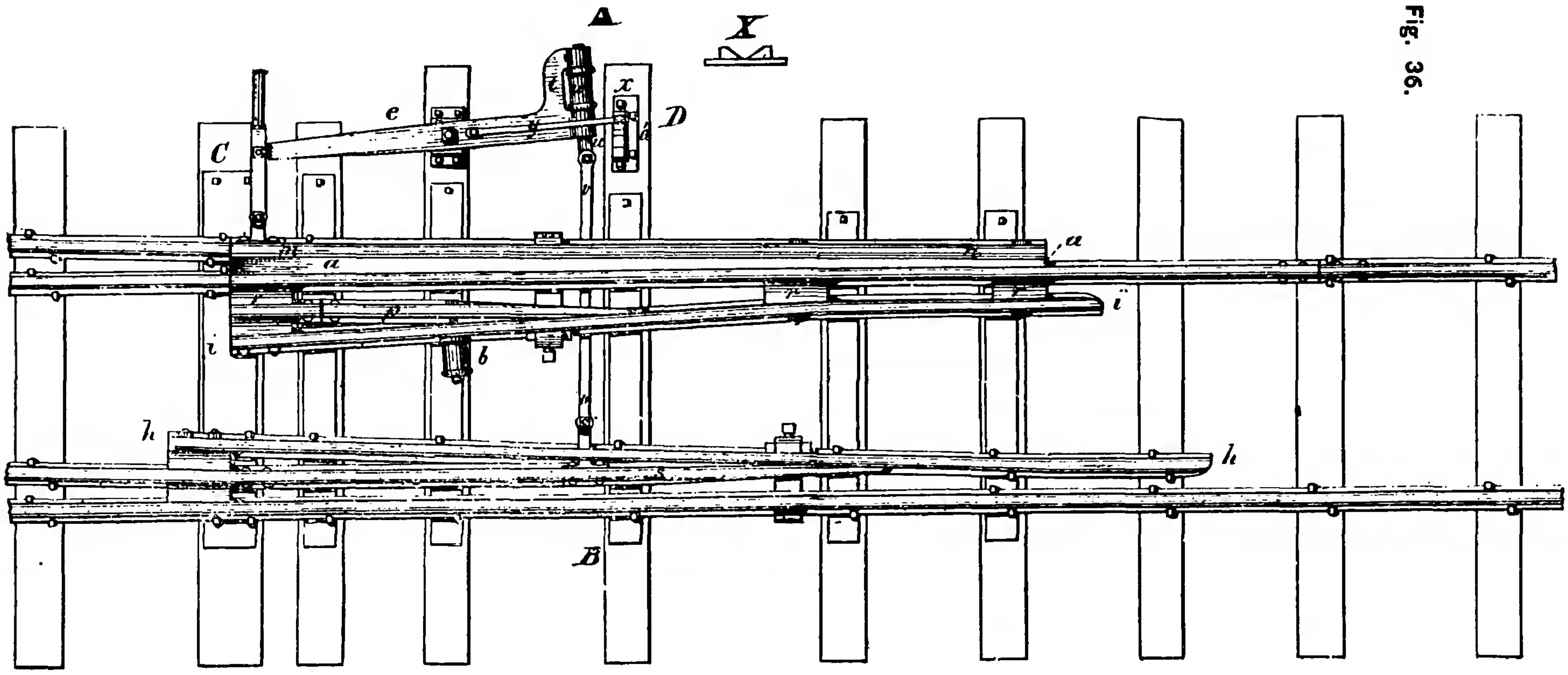


Fig. 35.

ings herewith show the switch in both positions, being set for the main in fig. 36 and for the siding in fig. 37. The moving side of this switch is constructed on the principle of a "Tyler" switch, but in a greatly improved and strengthened manner. The outside lifting piece, *a a*, is made of cast-iron: but is securely held against the main rail by an outside guard rail, *m n*. This casting fills the entire space between the main and guard rails (see section *A*, *B*, fig. 38), and in no danger of becoming detached or broken—or, if by any reason it should become broken, it will still answer its purpose, as it cannot by any possible means get out of place. On the inside or the main rail, the point that protects the main track, when the switch is set on the siding, is made of a short piece of rail, *p*, properly shaped and held away from the main rail, and against the guard rail by the rubber spring *b*. The inside guard rail is kept the proper distance from the main rail and the heel of the points by means of suitably shaped distance blocks, *r r*: the whole side is then held together by means or four strong bolts, and one heavy wrought-iron clamp. On the other side of the switch the main rail is "unbroken," and does not move at all. The rail of the siding terminates in a long point, *s*: this point is moved in the opposite direction to the other side of the switch by means of the lever *r*. The end of this lever has an arm, *t*, projecting to

Fig. 36.



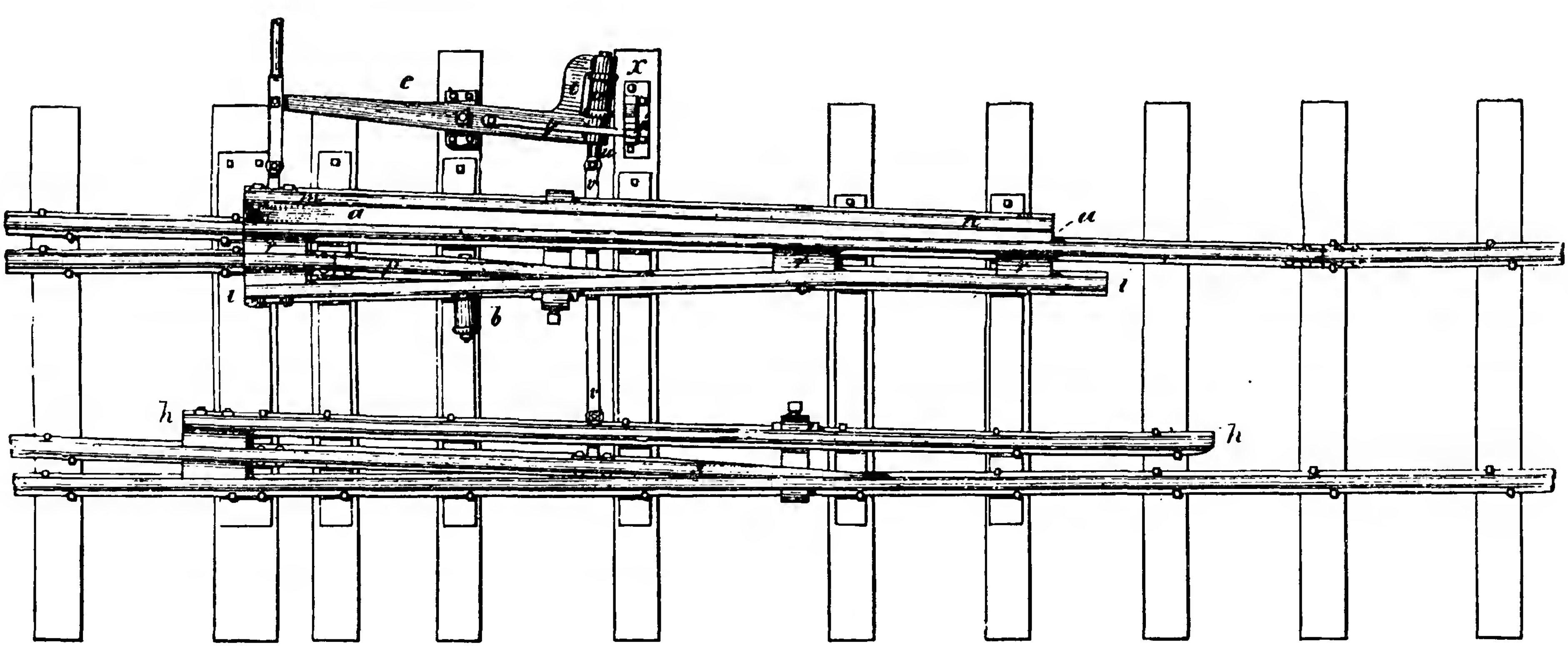
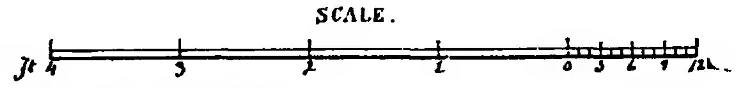


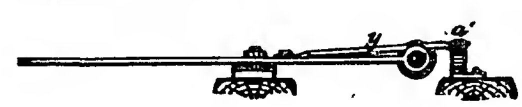
Fig. 37.

SCALE.



SECTIONAL ELEVATION ON LINE A B.

Fig. 38.



SECTION ON LINE C.D.

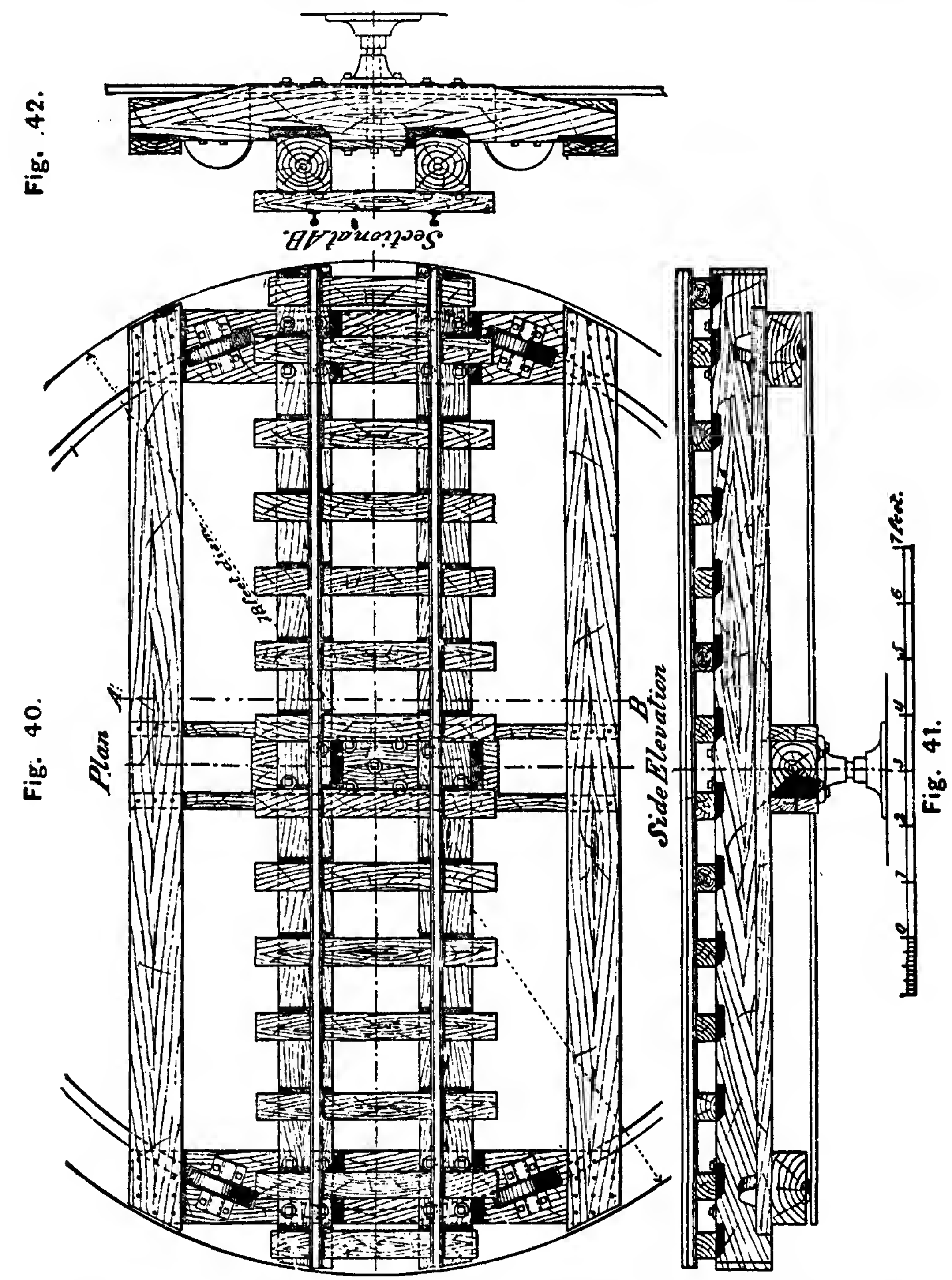
Fig. 39.

one side. A steel spindle, z z, passes through suitable bearings in the lever and this arm. Between the lever and arm, on this spindle, is placed a rubber spring, w, which may be compressed in either direction by means of washers that rest against suitable shoulders on the spindle. This spindle is connected with the moving point by means of a bent connecting rod, v v, which passes under the moving side of the switch (see sectional elevation A, B, fig. 38). On the top of this lever is placed a steel spring, y, which lies in an opening cut in the top of the bearing in the end of the lever, and at times drops into a slot in the steel spindle. It will be readily seen that when the steel spring has dropped down into the spindle, it will be impossible for the spindle to move in the lever; but, in order to free the spindle when the switch has been thrown into place, a hardened steel roller, a, is placed in the end of the steel spring. This roller passes over the surface of a cast-iron lifting-block, x (shown in front elevation at x), and the whole is so adjusted that when the switch is in place, either on the main track or the siding, the roller is on the top of this block and has lifted the spring up out of the spindle, which is thus left free to move in either direction and compress the rubber spring; but the moment the switch is moved the roller passes down the inclined surface of the block, and the steel spring drops into the spindle and securely locks it, and does not rise entirely out again until the switch is in its proper position. It will thus be seen that there is a *positive connection* between the switch-stand and the long moving point, so that it would be impossible to lock the switch-stand unless the long point was in place; but when the switch is set the point is then free to be sprung away from its adjoining rail by the passing wheel.

The operation of the switch is as follows: When the switch is set for the main track (see fig. 36), all the wheels passing on the main track have nothing but whole, solid rails to run upon. When the switch is in this position and a train comes in from the siding, the flanges of the wheels on the inside of the curve are lifted by the incline at the left end of the long lifting-piece a a to the level of the top of the main rail, when by means of the flanges on the opposite wheels pressing against the guard rail h h (which is spiked to the ties), they are drawn over the main rail and drop into place on the main track, the wheels on the outside of the curve pressing the long point s out of the way. This point then returns to its proper position, leaving the main line open and unobstructed. When the switch is set for the siding (see fig. 37), trains pass easily and smoothly in either direction. The guard rail i i draws the wheels away from the end of the long point so that it is impossible for them to strike against it. When a train comes from the left side on the main track the the flanges of the wheels merely press the points out of the way, no wheel is moved, either horizontally or vertically, from its natural course, and no jar or shock is felt by the passing train. After the train is gone the points resume their proper position for the switch on the siding.

On the 17th of December, 1877, the Railroad Commissioners of Massachusetts officially inspected the Billerica & Bedford Railroad. At their request one of these switches were set as shown in fig. 37, and a passenger train, moving at a fair rate of speed, was run over it on the main track.

It is needless to say that it passed safely and smoothly over it. On an earlier occasion Mr. Briggs, one of the commissioners, was present at Taunton when a heavy freight train of 34 cars was run over the switch



when it was set wrong. The train was moving at the rate of 27 miles per hour.

TURN-TABLE.

Fig. 40 represents a plan of the turn-table, fig. 41 a longitudinal section, and fig. 42 a transom section. It will be seen that this is only 18 ft. in

diameter, which is sufficiently large for turning the tank engines in use on this line. On ordinary roads, turn-tables are usually not less than 50 ft. in diameter for turning engines and tenders. Even for a much lighter class of engines and tenders a turn-table of 40 ft. diameter would be needed. One of the advantages of the tank engines used on this road is that the turn-tables and the engine-houses may be much smaller than would be required for engines with tenders.

The turn-table used on the Billerica & Bedford Railroad, it will be seen, is made of wood, and although we are not able to give its cost, from the drawing it is evident that it is a very cheap structure.

COST.

We regret that we are unable to give a complete account of the cost of this road or the indebtedness incurred in its construction. It was comparatively short-lived financially, as the road was put into the hands of an assignee before its completion. We have, however, received some data concerning its construction which may be of interest.

As we have stated before, the road is 8.63 miles long. There was in that distance 43,000 cubic yards of earth-work, and 542 cubic yards of loose rock and 640 of solid rock. The price paid for the grading was 35 cents per cubic yard for earth-work and $1.50 for rock-work. The cross-ties are 4 ft. 6 in. long × 4 × 6 in. section, and cost 12 cents each. The number laid per mile is 2,640, so that the distance between them, measured from centre to centre, is 2 ft. The rails weigh 25 lbs. per yard and are 30 ft. long; the quantity per mile being $39\frac{2}{7}$ tons, which cost in Boston $38 per ton. The spikes are $\frac{7}{16}$ in. square and $3\frac{1}{2}$ in. long, measured under the head. The quantity used per mile was 2,400 lbs., which cost $2\frac{3}{4}$ cents per pound. The rails are fastened with fish-plates $15\frac{1}{2}$ in. long, a pair of which weigh $5\frac{1}{8}$ lbs. Each pair has four bolts $\frac{1}{2}$ in. diameter and $2\frac{1}{4}$ in. long. One bolt and nut weighs a trifle ($\frac{1}{2}$ oz.) over a quarter of a pound.

The fish-plates cost 2 cents per pound and the bolts and nuts 4 cents, making the whole cost of a complete joint $14\frac{3}{4}$ cents. As there are 352 of them per mile, their cost for that distance is $51.92.

EQUIPMENT.

The equipment and its cost are as follows :

Two locomotives cost	$3,500	apiece.
One passenger car cost	2,000	
" combination " "	1,950	
Two excursion " "	490	"
One box " "	360	
Six platform " "	260	"
Two hand " "	65	"
Three push " "	35	"

The cars are all built of the best material, and have the Miller coupler. The passenger cars have the Empire vacuum brake. There are no station houses yet constructed on the line of the road, the only buildings being a car shed 22 × 112 ft., an engine house 22 × 36 ft., and a coal shed 18 × 32 ft. The water supply is furnished from a wooden tank in the engine house, the capacity of which is 15,000 gallons.

The estimated cost of the road was $50,000, but this will probably be considerably exceeded when the road is completed. The exact amount of indebtedness incurred thus far we have not been able to learn.

We have given as complete information concerning this enterprise as was accessible. The road and its rolling stock are well designed, and the whole project of constructing the road has been carried out with much ability by Mr. Geo. E. Mansfield, the General Manager of this line, so that the benefits to be derived from this exceptionally narrow gauge have been fully realized in this project. Our object has been to supply as full information concerning it as possible and to give it without comment.

All the rolling stock of this road has been purchased by the Sandy River Railroad Company, of Maine, which road is now being constructed, and is expected to be completed by Oct. 1, 1879. It will extend from Farmington to Phillips, a distance of eighteen miles, and is being built by Mr. Geo. E. Mansfield, Superintendent, whose present address is Phillips, Maine, and from whom any further information can be obtained.

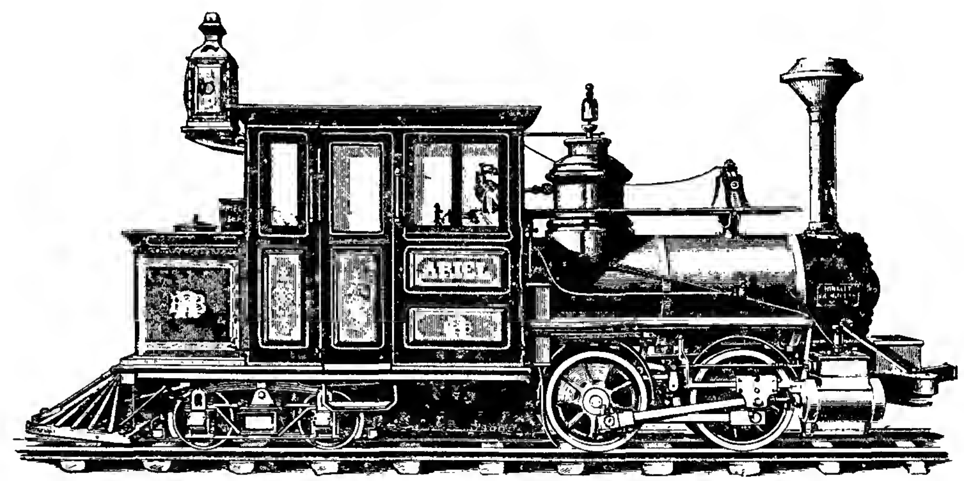
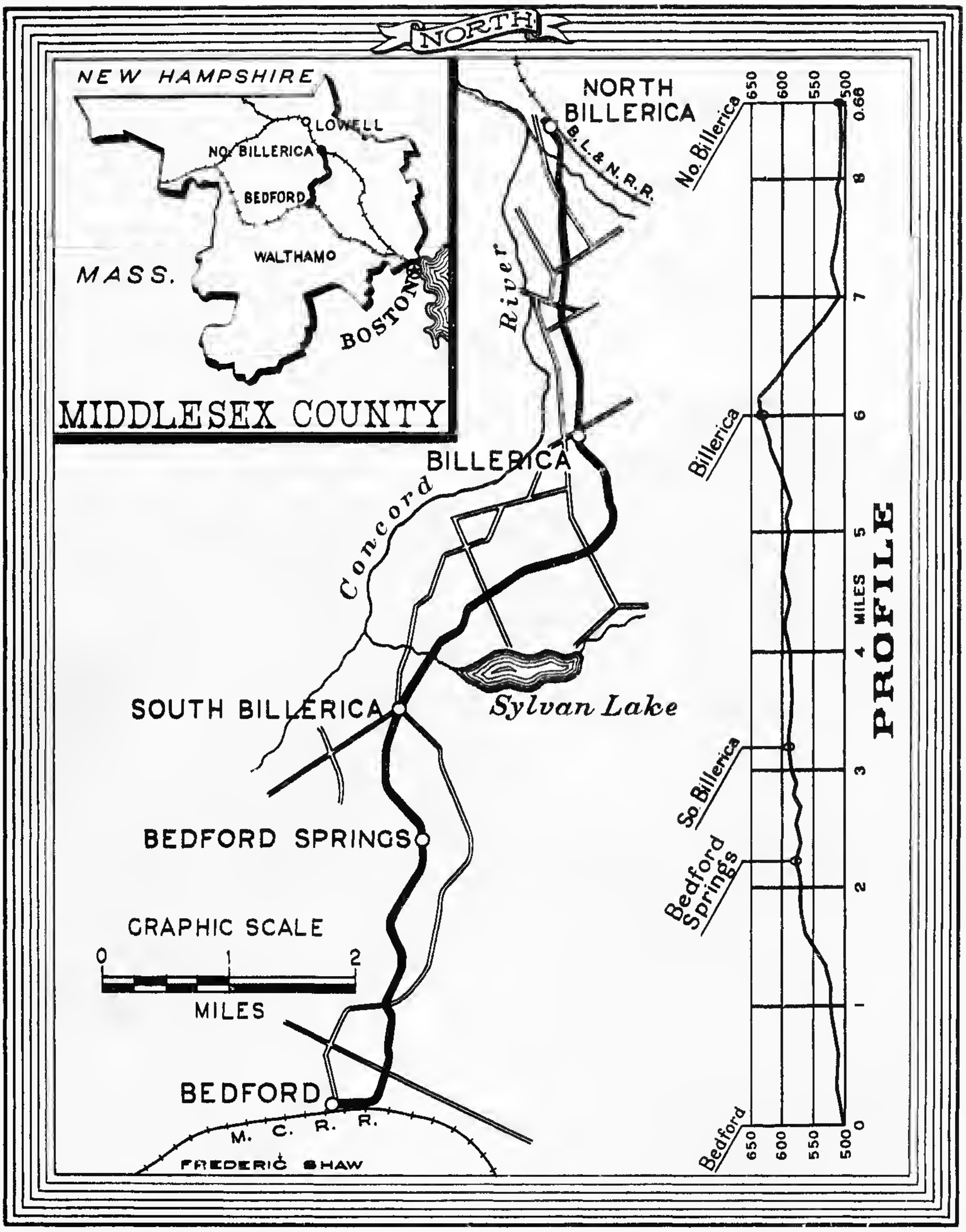


Fig. 9.

LOCOMOTIVE FOR THE BILLERICA & BEDFORD (TWO FEET GAUGE) RAILROAD

Built at The Hinkley Locomotive Works, of Boston.



ROUTE OF

The BILLERICA & BEDFORD RAILROAD
of MASSACHUSETTS

THE FIRST TWO-FOOT GAUGE RAILROAD